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Engineered grapevines produce a hybrid antimicrobial protein to block infection

Your evening glass of wine will still be available—despite the potential attack of a bacterium that causes Pierce's Disease and poses a significant threat to the California wine industry's valuable grapevines—thanks to LANL research.

Goutam Gupta, from the Lab's Bioscience Division and the Center for Bio-security Science, along with researchers at the University of California at Davis (UCD), and the U.S. Department of Agriculture's Agricultural Research Service, have created specially engineered grapevines that produce a hybrid antimicrobial protein that can block *Xylella fastidiosa* (*Xf*) infection.

Vineyards may rely less on chemicals to fend off bacterium

By helping the vine fight the microbe with specific proteins, the scientists envision vineyards requiring less reliance on chemicals as growers seek to fend off the bacterium and the glassy-winged sharpshooter (*Homalodisca vitripennis)* insect that carries it and transmits widely to the grapevines.

The key to the project's success is the fact that early in an *X fastidiosa* infection, a specific protein on the outer membrane of the microbe interacts with cells of the grapevine. By interfering with that interaction between microbe and vine, scientists can help the vines show resistance against the disease and go on to produce healthy grapes.

“One thing got us started: with almost any pathogen, the major problem is drug resistance,” said Goutam Gupta, the corresponding author of the PNAS paper. “We wanted the plant to clear itself of the pathogen without relying on drugs before it is infected, much as the body's immune system naturally recognizes a pathogen and takes action to defeat it.”

Finding the hybrid gene

It's been a long process, Gupta said, involving five years of work, with the initial protein's creation happening two years in, thanks to the efforts of former LANL postdoctoral researcher Meghan Norvell.

Then Anu Choudhary stepped in and partnered with UC Davis to do more testing, and now Paige Pardington "has taken things to a new level," said Gupta, finding where the hybrid anti-*Xf* gene is expressed in the plant and at what level. “This enables us to evaluate how well the hybrid anti-Xf strategy worked,” he said.

Identifying pre-symptomatic plants

In a separate effort, Paige Pardington has also developed research tools for identifying pre-symptomatic plants, i.e., the plants infected by *Xf* but are yet to show disease symptoms.

To make the effective protein, researchers fused two genes:

- one that encodes a protein to cut a specific protein on the outer membrane of *Xf*
- another that triggers the bursting of the *Xf* bacterium's outer wall, called lysis

The team inserted the hybrid gene into grapevines and observed the plants' response to *Xf* infection. “The hybrid protein apparently creates pores in the membrane of the Gramnegative bacterium, *Xf*," said Gupta, thus allowing the plant to fight back the infection. Sap from the engineered plants successfully killed *Xf* in laboratory tests, and the whole plant did not exhibit symptoms of Pierce's disease after exposure to the *Xf* bacterium.

Antimicrobial gene could protect other plants

The antimicrobial gene may also protect other economically important plants from *Xf*-related diseases, and a similar strategy may be effective against a broad range of pathogen-induced plant and human diseases, Gupta said. *X. fastidiosa* is implicated in

- oleander leaf scorch
- phony peach disease
- plum leaf scald
- almond leaf scorch
- Pierce's disease in grapes
- citrus variegated chlorosis disease in Brazil

Los Alamos National Laboratory **www.lanl.gov** **(505) 667-7000** **Los Alamos, NM**

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